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EVALUATION OF LVA FULL-SCALE HYDRODYNAMIC VEHICLE MOTION EFFECTS ON PERSONNEL PERFORMANCE

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A Full-Scale Hydrodynamic Vehicle (FSHV) has been constructed with size, weight, and speed characteristics corresponding to projected requirements for a future Landing Vehicle Assault (LVA) of planing hull type. Field test operations were conducted at Camp Pendleton to evaluate the effects of high-speed landings aboard the experimental LVA/FSHV on the performance of Marine infantrymen. The results provide a basis for DSARC I approval of LVA ride suitability for delivering Marines to battle positions without degrading their

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fighting capabilities. The following recommendations are considered applicable:

1. Design the future LVA to incorporate waterborne stability and ride quality characteristics equivalent to FSHV capabilities.

2. Incorporate the following habitability provisions aboard the future LVA:

a. Install noise and thermal insulation in bulkheads equivalent or superior to that in the FSHV.

b. If feasible, reduce heat discomfort by controlling the humidity level in occupant spaces.

c. Divert exhaust fumes away from ventilation intake openings.

d. Provide a closed loop ventilation system as protection against chemical, biological, and radiological warfare hazards.

FOREWORD

This effort was accomplished in support of the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) under reimbursable Work Request N00167-78-WR80199. The study investigated possible detrimental effects of high speed landings aboard a simulated Landing Vehicle Assault (LVA) on the performance of Marine infantrymen. The results provide a basis for DSARC I approval of LVA ride suitability for delivering Marines to battle positions without degrading their fighting capabilities.

A major field test effort such as that involving the LVA Full-Scale Hydrodynamic Vehicle (FSHV) cannot succeed without the cooperative support of many organizations. Special appreciation is extended to personnel of the Amphibian Vehicle Test Branch, Camp Pendleton, for their dedicated test coordination and logistic support that contributed greatly to the success of this project. The sustained high-level performance of volunteer test subjects from the 3rd Battalion, 5th Marine Regiment, Camp Pendleton, has been acknowledged in a separate letter of appreciation. Personnel of the Navy Environmental and Preventive Medicine Unit No. 5, San Diego, were particularly helpful in assessing the adequacy of FSHV environmental health provisions. Finally, Mr. Rene De Loach, the test vehicle driver furnished by Kettenburg Marine Company under DTNSRDC contract, served an indispensable function in safely piloting the experimental FSHV under variable sea state and speed conditions during the test period.

DONALD F. PARKER
Commanding Officer

SUMMARY

Problem

An advanced Landing Vehicle Assault (LVA) is being developed by the Naval Sea Systems Command (NAVSEA 03GB) and David W. Taylor Naval Ship Research and Development Center (DTNSRDC Code 112) for Marine Corps use. Following launching from over-the-horizon amphibious force ships, the LVA will transport troops at relatively high speed (25 mph or more) to beach or inland combat positions. The LVA will eventually replace the existing, much slower LVTP-7. The resolution of uncertainty concerning possible detrimental effects of high speed landings on troop performance has been identified as a critical milestone in the LVA development process. A Full-Scale Hydrodynamic Vehicle (FSHV) has been constructed with size, weight, and speed characteristics corresponding to projected requirements for a future LVA of planing hull type. The current test effort compared troop performance in landings aboard the experimental high speed FSHV with that in concurrent landings aboard the LVTP-7.

Background and Requirements

The LVA is being developed in response to updated Required Operational Capability (ROC) objectives promulgated by the Commandant of the Marine Corps in February 1978 (MOB 1.05). The future LVA will carry 18 to 20 troops. Candidate vehicle configurations under consideration for the future amphibious mission include both planing hull and air cushion types. Initial emphasis has been placed on verifying planing hull operational feasibility.

The test reported herein was designed to demonstrate that the performance of troops landing aboard a high speed planing hull vehicle such as the LVA/FSHV after a 1-hour open-ocean transit will equal or exceed that of troops landing aboard the existing LVTP-7 after a 30-minute transit. The variation in transit time reflects the typical scenario applicable to each vehicle. The requirement for equal or better performance by FSHV troops even though waterborne time was doubled placed a heavy burden upon the experimental vehicle in demonstrating acceptable ride quality habitability. This was considered to be a realistic and achievable requirement.

Approach

The LVA/FSHV test plan provided for quantitative and qualitative evaluation of experimental vehicle ride effects. The qualitative data were gathered by administering a ride quality questionnaire near the end of test operations, after participants (18 Marine infantrymen) had gained experience in landings under a variety of conditions. The Marines were asked to assess ride acceptability and to compare the FSHV ride with that of the LVTP-7, noting any particularly liked or disliked features.

Quantitative data consisted of scores achieved on test tasks following landings aboard the FSHV and LVTP-7. The tasks were representative of Marine activities normally associated with beach landing operations. Combat troops must be able to move quickly and fire accurately after transit through inshore waters. Time expended and problems encountered in traversing an obstacle course following landing were recorded for each test subject. Firing accuracy following the obstacle course run was also evaluated. The test facilities were located near the FSHV and LVTP-7 landing positions at Camp Pendleton.

Vehicle trials were planned to ensure that each squad of test subjects would be deployed aboard the FSHV for at least two landings at 25, 30, and 35 mph. Concurrent LVTP-7 operations were conducted, with squads rotating between the two vehicles. Test data were initially examined by tabulating obstacle course and rifle firing mean scores for each trial. Statistical tests of the data employed analyses of variance (ANOVA) to determine whether observed differences in performance were statistically significant or attributable to chance variations.

Conclusions

1. There was less than 5 percent variation in the mean performance level of troops landing aboard the FSHV and LVTP-7. In most cases, the performance of troops landing aboard the FSHV was better than that of troops landing aboard the LVTP-7, although the difference was not statistically significant.

2. The FSHV ride was indicated as "satisfactory" by two-thirds of the test subjects. The remaining one-third considered the ride to be "fair." None of the subjects judged the ride as "poor."

3. Seventy-two percent of the participants considered the low noise level within the FSHV troop compartment to be advantageous. This avoided the use of ear plugs and facilitated verbal communications between troops while underway.

4. The most disliked feature of the FSHV troop compartment was the heat discomfort reported by 94 percent of the troops, although measured temperature did not exceed 90° F. It is likely that high relative humidity (typically 80%) while underway contributed to this perception of heat.

Recommendations

1. Design the future LVA to incorporate waterborne stability and ride quality characteristics equivalent to FSHV capabilities.

2. Incorporate the following habitability provisions aboard the future LVA:

a. Install noise and thermal insulation in bulkheads equivalent or superior to that in the FSHV.

b. If feasible, reduce heat discomfort by controlling the humidity level in troop spaces.

c. Divert exhaust fumes away from ventilation intake openings.

d. Provide a closed loop ventilation system as protection against chemical, biological, and radiological warfare hazards.

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CONVERSION FACTORS

Units of measurement used in this report may be converted to equivalent values in accordance with the chart shown below.

Meters = Feet x 0.3048
Kilometers = Miles x 1.6093
Meters^3 = Feet^3 x 0.0283
Inches = Millimeters x 0.0394
Inches^2 = Millimeters^2 x 0.0155
° Centigrade = 5/9 (° Fahrenheit - 32)

INTRODUCTION

Problem

An advanced Landing Vehicle Assault (LVA) is being developed by the Naval Sea Systems Command (NAVSEA 03GB) and David W. Taylor Naval Ship Research and Development Center (DTNSRDC Code 112) for Marine Corps use. Following launching from over-the-horizon amphibious ships, the LVA will transport troops at relatively high speed (25 mph or more) to beach or inland combat positions. The LVA will eventually replace the existing, much slower LVTP-7. The resolution of uncertainty concerning possible detrimental effects of high speed landings on troop performance has been identified as a critical milestone in the LVA development process.

Purpose

This report presents the results of test operations conducted at Camp Pendleton during June through August 1978 for evaluation of experimental high speed landing vehicle motion effects on the performance of Marine infantrymen. A Full-Scale Hydrodynamic Vehicle (FSHV) was used with size, weight, and speed characteristics corresponding to projected requirements for a future Landing Vehicle Assault (LVA) of planing hull type. The objective was to compare troop performance in landings aboard the experimental high speed FSHV with that in concurrent landings aboard the LVTP-7.

Background

The LVA development effort, including initial feasibility test requirements, is described in various working papers and planning documents (principal reference documents are listed on pages 25 to 27). Material from these sources is summarized herein where appropriate to provide background information.

The LVA is being developed in response to an updated Required Operational Capability (ROC)—MOB 1.05—promulgated by the Commandant of the Marine Corps in February 1978 (Note 1). Future amphibious landings will be initiated at greater distance offshore for protection against long-range weapons fire during launching and form-up phases. The LVA will provide this capability. Survivability will be enhanced by improvements in speed, protective armor, and integral offensive firepower. Provisions will be made for protection against chemical, biological, and radiological hazards to the extent feasible with systems available during development. Initial field introduction is planned for FY 1989, although earlier availability is desirable (Note 1). Candidate vehicle configurations under consideration for this amphibious mission include both planing hull and air cushion types. Initial emphasis has been placed on verifying planing hull operational feasibility.

The planing hull FSHV is illustrated in Figure 1. Troop carrying capacity is limited to nine men in the experimental vehicle in order to accommodate commercially available Detroit Diesel engines (four 8V-71TI units), test instrumentation, and observers. A capacity for land operations is not provided,

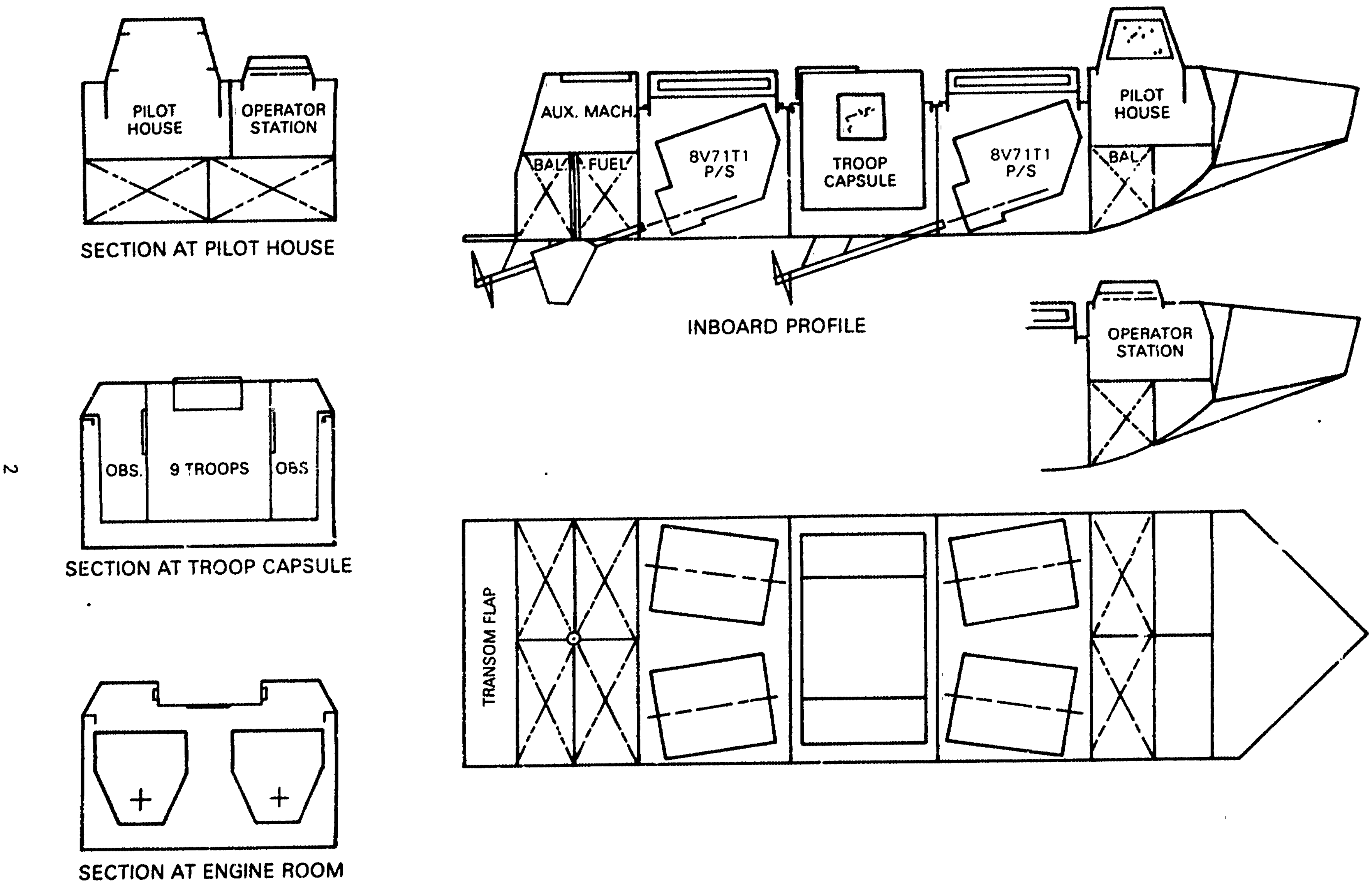


Figure 1. Experimental full scale hydrodynamic vehicle (FSHV) configuration.

since this would increase experimental hull complexity and raise costs unnecessarily. Hull dimensions are limited by the eventual number of troops to be transported (18 to 22 in each vehicle) and the need for size compatibility with amphibious ships' well deck storage space. (Each vehicle is limited to an 11-foot width, an 11-foot height, and a 33-foot length for effective use of available space.)

The LVA/FSHV project is under the technical management of DTNSRDC Code 112. The FSHV was constructed under a competitive contract awarded to Monark Boat Company, Monticello, Arkansas. Initial trials to verify vehicle operational readiness, safety, and test procedures were supervised by DTNSRDC. Responsibility for on-site direction of test operations was subsequently assigned to the Amphibian Vehicle Test Branch (AVTB), Marine Corps Tactical Systems Support Activity, Camp Pendleton, effective 1 June 1978 (Note 2). Troop performance tests were conducted by the Navy Personnel Research and Development Center (NAVPERSRANDCEN), San Diego, with the participation of AVTB. Volunteer Marine infantry test subjects were made available by the 3rd Battalion, 5th Marines Regiment at Camp Pendleton. Test participants are further identified in Appendix A.

TEST PROCEDURES

Approach

The test reported herein was designed to demonstrate that the performance of troops landing aboard a high speed planing hull vehicle such as the LVA/FSHV after a 1-hour open-ocean transit will equal or exceed that of troops landing aboard the LVTP-7 after a 30-minute transit. This difference in transit times reflects the expected mission scenario of each vehicle. The requirement for equal or better performance by FSHV troops even though waterborne time was doubled placed a heavy burden upon the experimental vehicle in demonstrating acceptable ride quality and habitability. This was considered to be a realistic and achievable requirement.

As part of the LVA/FSHV design process, special attention was directed to potential habitability problems (noise, ventilation, temperature, and air quality). These conditions were measured prior to the start of landing trials and found to be in compliance with MIL-STD-1472B.

Test subjects participated in orientation training and practice in performing test tasks prior to commencement of landing trials. Initial testing established individual baseline scores. Subsequent performance after landing aboard the FSHV was then compared with baseline and LVTP-7 landing scores. The LVTP-7 has been in use for several years, and the performance level of troops after landing has generally been acceptable. This performance level thus provided a convenient yardstick for assessing the adequacy of scores attained in experimental vehicle trials.

The FSHV master test plan (Note 3) was prepared by DTNSRDC, specifying vehicle acceptance and shakedown tests and personnel tests proposed by NAVPERSRANDCEN (Stinson, 1977). Test procedures were further specified in the updated plan prepared by AVTB (Note 4).

Test subjects were 18 Marine infantrymen with at least 1 year of service experience and Class 2 swimmer qualifications. Subjects were equipped with flak jackets, life jackets (Mae West type), and helmets. Two rifle squads were formed, with a Squad Leader (Cpl) and eight Riflemen in each squad. An NCO (Sgt) was assigned as Platoon Leader (not a test subject) and assisted in supervising rifle range operations.

Performance Test Tasks

The tasks selected for performance testing are representative of Marine activities normally associated with beach landing operations. Combat troops must be able to move quickly and fire accurately after transit through inshore waters. Time expended and problems encountered in traversing an obstacle course following landing were recorded for each test subject. Firing accuracy following the obstacle course run was also evaluated.

Test facilities were located near the FSHV and LVTP-7 landing positions. Transportation to a remote firing area was not considered feasible inasmuch as the effects of waterborne transit could have been changed by further land travel.

The obstacle course started at a point about 700 feet from the FSHV and LVTP-7 landing positions. The course was 300 feet long. There were two parallel lanes, with five pairs of obstacles located at intervals along the lanes as illustrated in Figure 2. The obstacles included a 6-foot vertical wall, cargo net ladder (12-foot height), horizontal balance beams, staggered tires, and inclined balance beams. The course was intended to test balance, agility, and coordination.

Rifle firing was accomplished at the Army Reserve's indoor range located 1240 feet beyond the obstacle course. Precision air rifles with verified accuracy were used to fire .177 and .22 caliber pellets at bullseye targets as shown in Figure 3. Nine firing stations were set up to accommodate simultaneously all test subjects within a squad. Subjects simultaneously fired 10 rounds, first sitting and then standing, within 2 minutes in each case. Targets were 25 feet from the firing line. Preliminary testing showed that Marines needed considerable practice to achieve a reasonably high score when firing at this distance.

Deployment Scenario

Prior to getting underway, both vehicles were stationed at the Del Mar boat basin, Camp Pendleton. The FSHV tied up at a pier to load or unload troops while the LVTP-7 used a designated beach site.

Transit between loading or unloading points and the open ocean involved about 5 minutes for each vehicle. Open-ocean operations were conducted in an area extending about 5 miles beyond the harbor breakwater. A waverider buoy in the maneuvering area measured sea state during operations. The required maneuvers provided adequate wave variety (head, bow, beam, quartering, and following seas). Total time underway was 40 minutes for the LVTP-7 and 70 minutes for the FSHV.

Evaluation Phases

Evaluation phases were beginning baseline, LVTP-7 and FSHV landing cycles, and termination baseline, with objectives as outlined below.

Baseline Before Running (BBR)

Baseline performance level was measured with the troops fully rested prior to deployment aboard vehicles. No running was required between test positions.

Baseline After Running (BAR)

Baseline performance level after running between vehicle landing sites and test positions (obstacle course and rifle range) was measured prior to deployment.

LVTP-7 and FSHV Landing Cycles (P7L/HVL)

Performance level was measured after open-ocean deployment (30 minutes for LVTP-7 and 1 hour for FSHV). Speed of FSHV was specified as 25, 30, or 35 mph for runs under specified sea state conditions. Concurrent LVTP-7 operations were conducted at 7 mph.

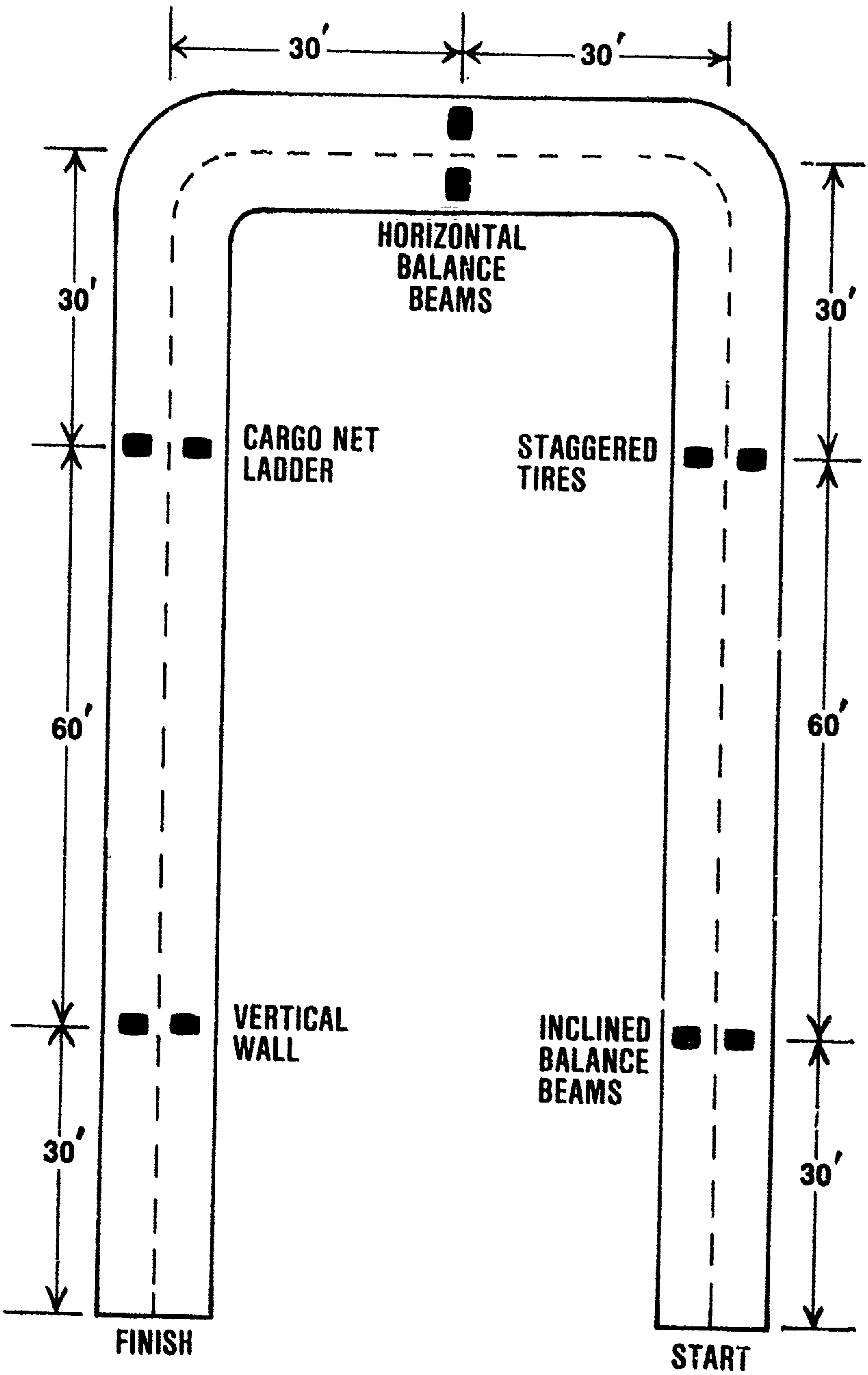
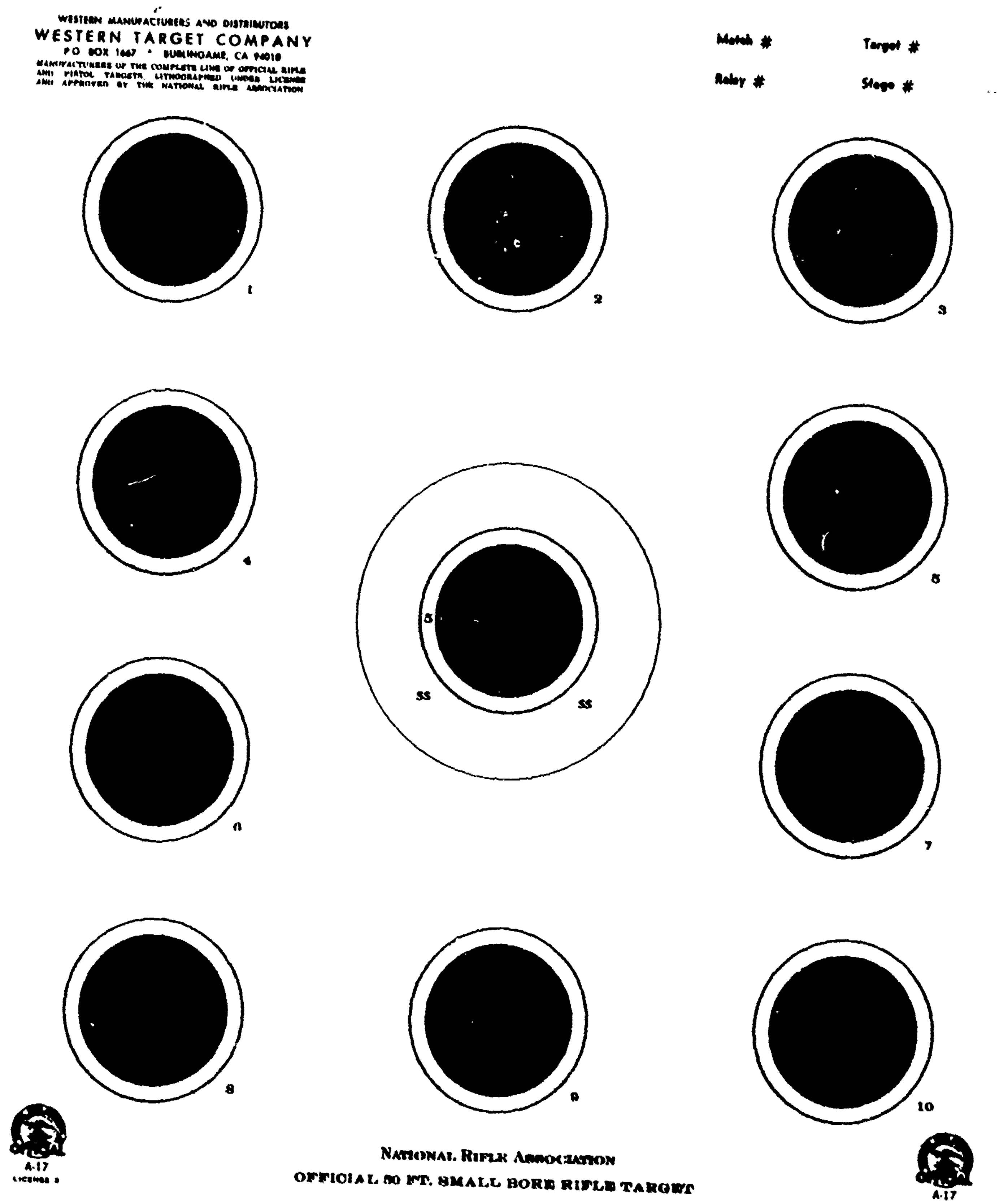


Figure 2. Obstacle course configuration.



Note: Size of target sheet reduced for illustration purposes. Normal size is 10.5 inches width by 12.0 inches height.

Figure 3. Rifle target sheet.

Posttest Before Running (PBR)

Performance level was measured with troops fully rested after termination of vehicle trials. No running was required between test positions.

Posttest After Running (PAR)

Performance level was measured after the troops had run between vehicle landing sites and test positions (obstacle course and rifle range) following termination of vehicle trials.

Vehicle trials were planned to ensure that each squad would be deployed aboard the FSHV for at least two runs at 25, 30, and 35 mph under specified sea state conditions of greatest concern. The "worst case" sea state for operations at full speed was defined in ROC documentation as involving swells at 5.5 feet significant height (average of highest one-third) with 11 seconds period combined with wind-generated waves of 2.2 feet significant height (sea state 2 based on the Pierson-Moskowitz wave spectrum). One run per squad was planned for other less severe sea state conditions as shown in Table 1 below.

It was found that test facilities and personnel could be employed most efficiently by conducting vehicle runs whenever observation of sea state indicated that operations could be conducted safely. Waverider buoy measurements were concurrently recorded on magnetic tape for subsequent power spectrum analysis (computer-assisted) to determine precisely sea state conditions. Wave amplitude data were recorded as a time history trace on a strip chart.

The strip chart data cannot readily be converted into separate components differentiating wind-driven waves superimposed on ocean swells. The combination power spectrum may provide a more practical and useful indication of sea state conditions. Preliminary data from DTNSRDC indicate that significant wave height during the test period ranged from 0.64 meters (2.10 feet) to 1.36 meters (4.46 feet), with a mean of 0.95 meters (3.12 feet). The period between maximum energy peaks ranged from 8.5 to 17.1 seconds, with a mean of 13.6 seconds.

Trials were arranged in phases corresponding to FSHV speed increments, starting with 10 runs at the medium high speed of 30 mph, followed by 10 runs at 25 mph and 5 runs at 35 mph for an overall total of 25 runs. An additional 6 runs were started, but various difficulties precluded successful completion.

Safety

The FSHV was operated under the control of a highly qualified civilian test driver furnished by Kettenburg Marine Company, San Diego, through DTNSRDC. Backup Marine Corps drivers (MGySgt/SSgt) were assigned to the alternate driver position with access to dual driver controls. It was found that Marine Corps drivers could safely operate the vehicle after brief on-site training. At times, both primary and alternate driver duties were handled by the Marine Corps drivers under civilian test driver supervision (Pilot House observer position). A rescue safety boat was in the area of operations during all underway operations. Radio contact was maintained between underway units and the project control center ashore.

Table 1

Planned Deployment Conditions for FSHV Trials[a]

Ocean Swell Significant Height (ft)	Wind Wave Significant Height (ft)	Speed (mph)		
		25	30	35
0 - 1.9	0 - 1.5	0	0	0
	1.5 - 3.0	0	0	0
2.0 - 2.9	0 - 1.5	0	0	0
	1.5 - 3.0	0	1	1
3.0 - 3.9	0 - 1.5	0	0	0
	1.5 - 3.0	0	1	1
4.0 - 4.9	0 - 1.5	0	1	1
	1.5 - 3.0	0	1	1
5.0 - 5.9	0 - 1.5	0	1	1
	1.5 - 3.0	2	2	2

[a]Extracted from: LVA full scale hydrodynamic vehicle (FSHV) ride quality demonstration plan. Camp Pendleton, California: Amphibian Vehicle Test Branch, 25 May 1978. Completion of at least two "worst case" runs planned for each squad of test subjects. Other runs optional--dependent upon availability of desired sea state conditions during test period.

Test subjects were briefed concerning proper handling of air rifles and the need to wear life jackets aboard test vehicles. Ear plugs were worn aboard the LVTP-7. The noise level aboard the FSHV was found to be well controlled by soundproofing in compartment bulkheads, eliminating the need for hearing protectors. Air pollutants (carbon monoxide, nitrogen dioxide, and carbon dioxide) were found to be within allowable limits aboard both vehicles.

A Hospital Corpsman was aboard the FSHV for observation and treatment of embarked troops. Follow-up dispensary and hospital treatment was available, and troops were examined before and after test operations to verify physical fitness.

Approval for Use of Human Subjects

Under guidance established by SECNAVINST 3900.39A, proposed experiments involving the use of Navy or Marine Corps personnel must be approved by a Committee for the Protection of Human Subjects (CPHS). Upon CPHS approval, further endorsement by the Chief, Bureau of Medicine and Surgery is required. The FSHV test protocol was approved by the Naval Regional Medical Center, San Diego in July 1977 and further approved by BUMED in August 1977 (Note 5; Note 6).

Risks associated with FSHV underway operations were reduced as the result of model basin tests at DTNSRDC and Stevens Institute of Technology (Davidson Laboratory), Hoboken, New Jersey, that determined vehicle waterborne stability. Safe ride characteristics were further demonstrated in vehicle acceptance and shakedown trials prior to embarkation of test subjects. This pretest safety validation, together with protective measures prescribed for trials, provided a high level of confidence that test operations would not cause injury to human subjects.

Information was provided to potential participants concerning test objectives, procedures, and possible risks prior to obtaining their consent. The voluntary nature of the project was emphasized, including the right of subjects to withdraw from the experiment at any time without consequence.

Ride Quality Questionnaire

In addition to quantitative evaluation of performance scores, the test provided for qualitative assessment of ride acceptability using the questionnaire shown in Appendix B. Results are provided in Appendix C.

Subjects were asked to compare the FSHV ride with that of the LVTP-7 and to note characteristics particularly liked or disliked. Subjects were also asked to identify possible improvements that should be incorporated in the future LVA. The questionnaire requested background information concerning the number of amphibious landings made by test subjects in the past and any motion sickness problems previously experienced. The questionnaire was administered near the end of test operations, after each subject had participated in at least 12 landings aboard the FSHV and LVTP-7.

Scoring Procedures

Obstacle Course

The measures of interest consisted of time to run the course and number of observed errors. Possible errors consisted of falls, failure to step in tire holes, running outside marked lanes, and failure to go over or through an obstacle.

Upon running from vehicle landing positions to the obstacle course, subjects assembled in numerical sequence and started through the course at 15-second intervals (initiated automatically by electronic signal). A semi-automatic timer was activated by a test observer as each subject started and was deactivated by push button control as each subject reached the finish line, providing a printed paper-tape log of elapsed times. The sequence in which subjects started at the obstacle course was reversed after each trial. Assignments to left-hand or right-hand running lanes were similarly reversed after each trial.

Errors were noted by observers using hand-held voice tape recorders. Television cameras were also used to record obstacle course operations on video tape. This equipment provided a useful backup capability, permitting reexamination of errors and run times.

Rifle Firing

Each test subject was assigned a specific rifle for use throughout the test. Rifle firing measures consisted of ring score, miss distance, hit group size, bearing (quadrant) of hit group center, and number of unfired rounds. Scores were calculated separately for standing and sitting positions prior to averaging to provide a combined value for each performance element.

The ring score was calculated manually, following normal marksmanship scoring practice whereby a bullseye hit receives a value of 10 and hits in other rings away from bullseye receive marks of 9, 8, 7, etc. Since there were ten separate targets on each target sheet, scores from 0 to 100 were theoretically possible.

The ring score provided a quick measure of firing accuracy useful for immediate feedback. More precise determination of miss distance was considered desirable, however, and this was accomplished by recording the cartesian grid coordinates (x, y values) of each hit, facilitating use of a computer for repetitive calculations. Thus, it was possible to establish the centroid position of all hits combined on each target sheet as the mean of cumulative x and y values. This in turn permitted calculation of the miss distance of each hit in relation to the centroid. The mean miss distance from the centroid served as the radius of a circle in calculating group size.

The location of the hit group center provided the directional orientation of all hits combined on each target sheet. Directional orientation was noted in terms of the quadrant encompassing the hit group center. It was not considered worthwhile to further calculate a consolidated directional orientation for combined target sheets, since this would have no apparent relevance as a meaningful indicator of group performance.

The number of unfired rounds was noted on evaluation sheets after each 2-minute firing period. Subjects seldom experienced any difficulty in discharging all rounds within the allowed time period. Similarly, errors at the obstacle course were observed to occur at an extremely low rate. The observed frequency of errors and unfired rounds eliminated these factors as useful indicators of changes in group performance.

Gun sights were carefully adjusted and firmly secured during pretrial practice. Accuracy was checked periodically throughout the test period as a precaution against changes in sighting due to firing and handling. Centroid miss distance and group size measures were particularly useful indicators of rifle firing performance. Such measures are essentially unaffected by gun sight drift problems.

EVALUATION RESULTS

Analysis Approach

The LVA/FSHV test protocol provided for analysis of experimental vehicle ride effects based on both qualitative and quantitative data (Note 7). The qualitative data are limited to the perceptions of test subjects as reflected in a ride quality questionnaire.

The quantitative approach involved a series of comparative analyses to determine the significance of differences in the performance of individuals and the overall test group during the following test phases:

1. Baseline before running vs. baseline after running.[1]
2. LVTP-7 landing cycles vs. FSHV landing cycles.
3. Posttest before running vs. posttest after running.[1]

Statistical tests of the data employed analyses of variance (ANOVA) to determine whether observed differences in performance were statistically significant or attributable to chance variations. This involved comparison of the mean difference in performance <u>between</u> groups under various test conditions against the variability of individuals <u>within</u> each group. If the performance variability of individuals <u>within</u> a group exceeds the mean difference <u>between</u> groups in comparative tests, then it cannot be said that there has been any real change in performance attributable to different conditions existing in the test modes. The ANOVA evaluation was applied to principal measures of performance at the obstacle course (run time) and rifle range (ring score, centroid miss distance, and group size).

Test data were initially examined by tabulating obstacle course and rifle firing mean scores for each phase of test operations. This facilitated the preparation of tables and figures illustrating performance level changes associated with the various test phases.

Quantitative Results

Performance scores are tabulated for all trials (baseline, vehicle landings, and posttest) in Appendix D and illustrated graphically in Figures 4 through 7. There is less than 5 percent variation in the mean performance level of troops landing aboard the different vehicles as shown by obstacle course run time, rifle firing ring score, and rifle firing group size when summarized in test phases corresponding to FSHV speed increments (25, 30, and 35 mph). The location of rifle firing group center (centroid) in relation to target bullseye shows greater variation (up to 15.4%). In most cases, troops landing aboard the FSHV performed better than those landing aboard the LVTP-7.

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[1]Running between test facilities was performed at a standard doubletime pace of 180 steps per minute starting at vehicle landing sites (alternating between beach and pier positions), proceeding to the obstacle course, and terminating at the rifle range.

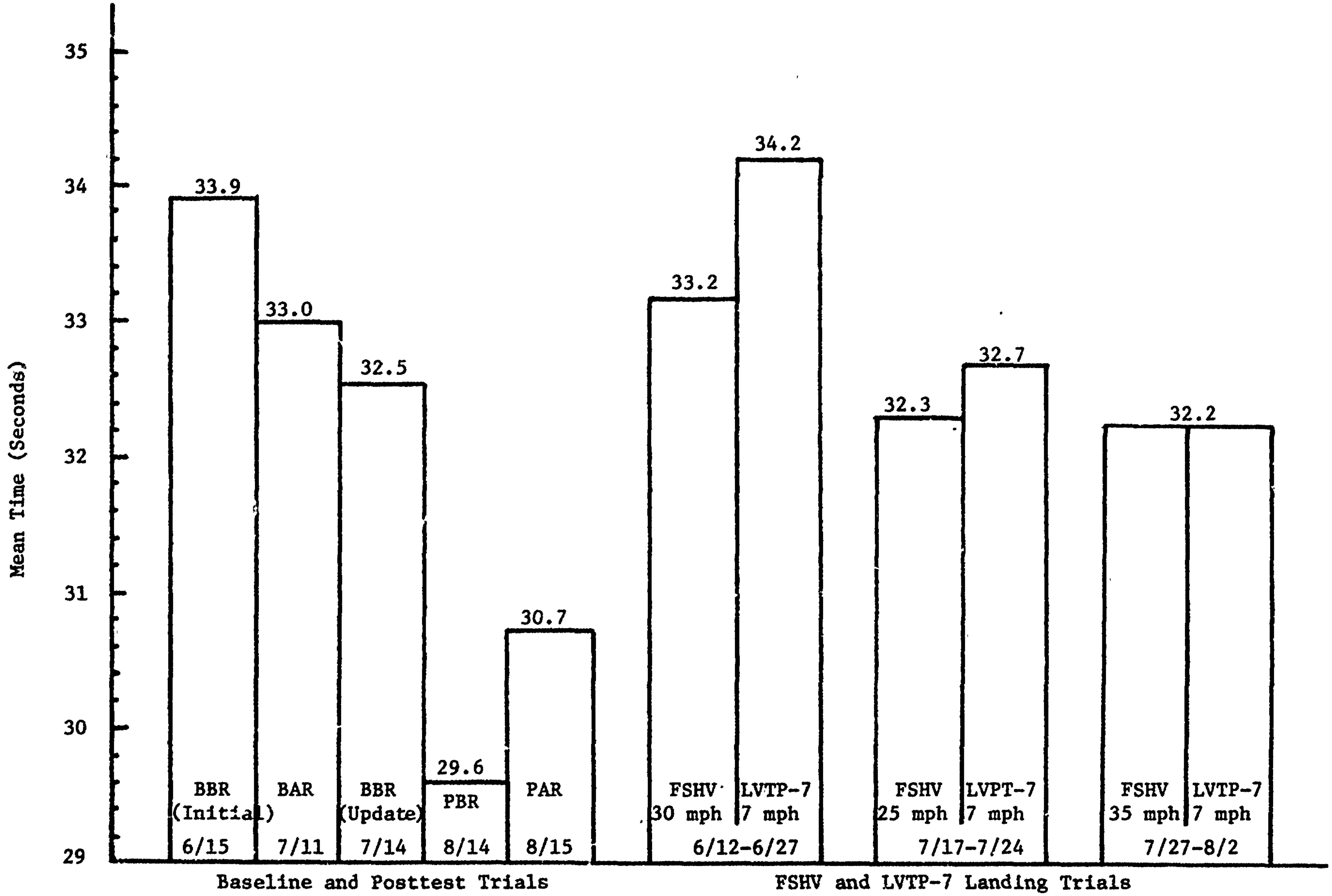

Figure 4. Obstacle course run time.

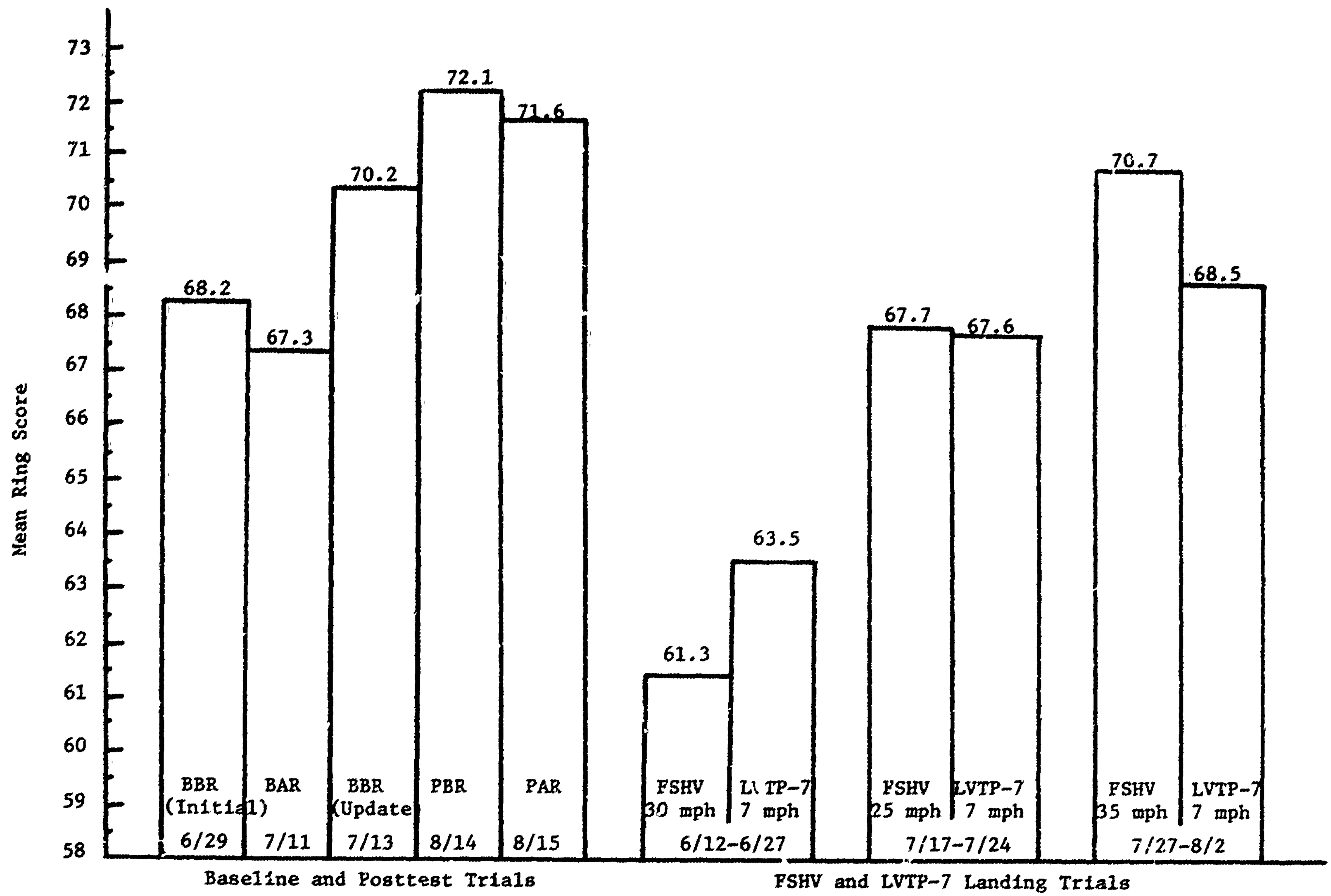

Figure 5. Rifle firing ring score.

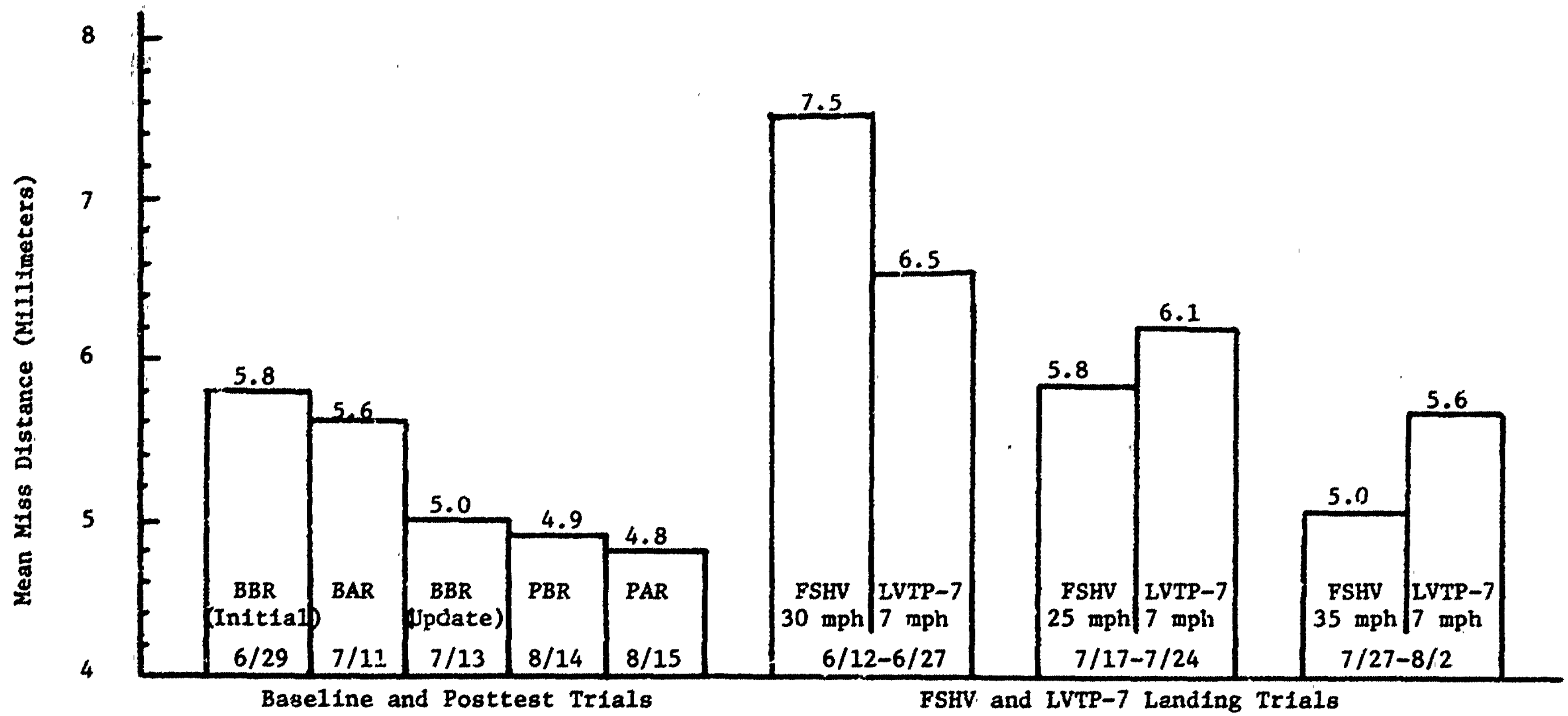

Figure 6. Rifle firing miss distance (centroid).

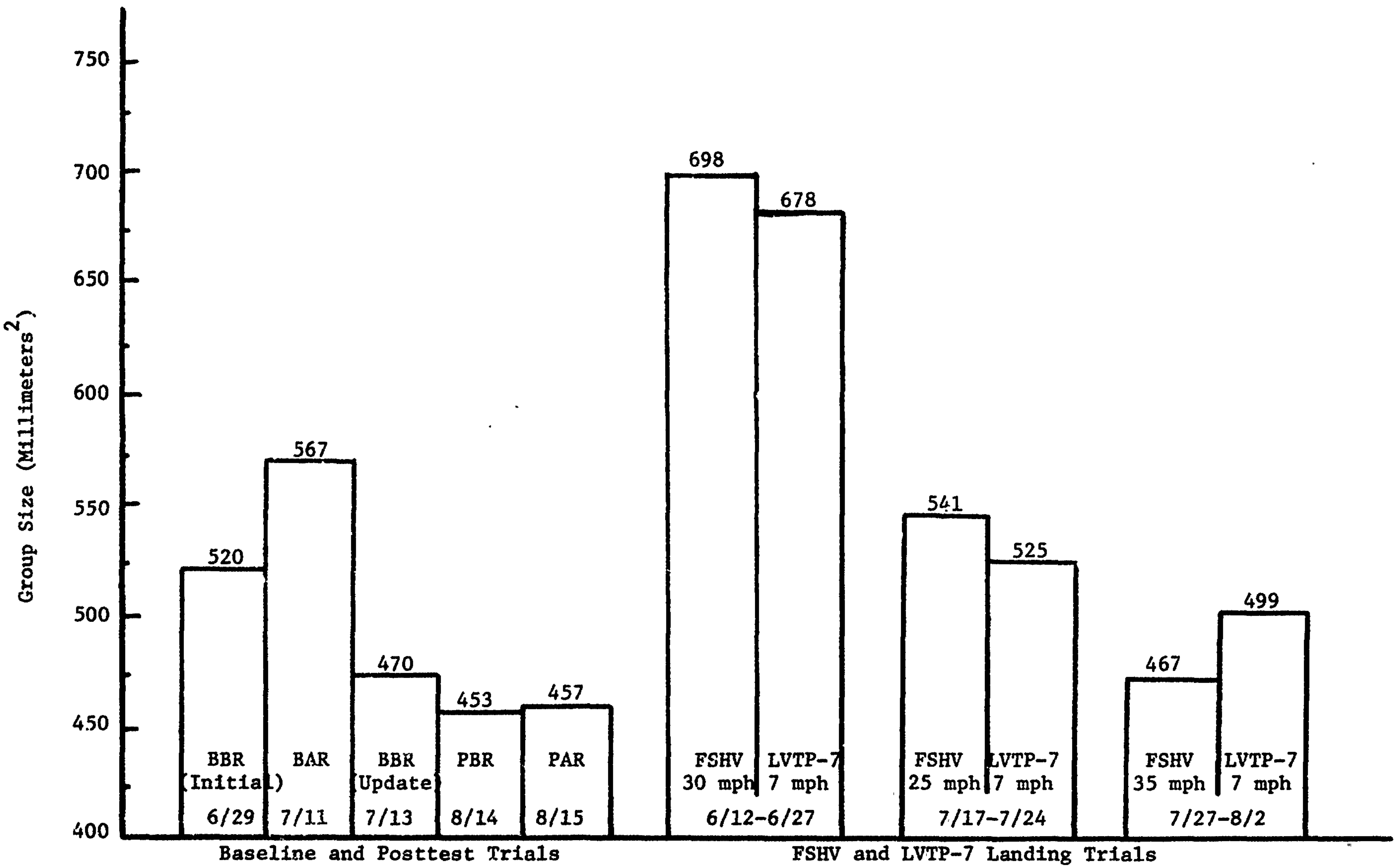

Figure 7. Rifle firing group size.

Baseline and posttest scores indicate consistent changes in performance throughout the test period. As would be expected, task performance before running (BBR/PBR) is always slightly better than performance after running (BAR/PAR) at comparable dates in the test schedule. Similarly, baseline and posttest performance ashore (no vehicle deployment) were always better than performance after deployment at comparable dates in the test schedule. The difference in almost all cases is less than 10 percent.

It was anticipated that task proficiency would improve throughout the tests. The analysis approach therefore required that performance comparisons be arranged to evaluate trial phases occurring at approximately concurrent times. This provided a balanced factorial design with independent variables consisting of vehicle type (LVTP, FSHV) and operational mode by trial sequence. Thus, it was possible to perform a two-way analysis of variance to determine significant vehicle and sequential mode or trial condition effects on troop performance. Trial runs were evaluated in blocks as data became available throughout the test period. Using this approach, significant differences in performance during any test phase would be indicated by ANOVA results (F ratios) in excess of critical limits at the 0.05 level of significance. The ANOVA ratios are tabulated in Appendix E.

The type of vehicle, whether FSHV or LVTP-7, had no significant effect on obstacle course run time, rifle firing ring score, or rifle firing group size during any of the test phases. There was an effect on the distance of rifle firing group center (centroid) away from bullseye during one phase of operations (runs 15, 16, 17, 18, 19, and 20), with consistently better performance indicated for troops landing aboard the FSHV (mean miss distance of 5.7 millimeters vs. 6.8 millimeters).

Relatively large variations in rifle firing ring score occurred during LVTP-7 Trials 6, 7, 8, and 9, ranging from a minimum ring score of 57.8 for Trial 9 to 68.4 for Trial 7 (10.6 points or 18.3%). A lesser change was noted for concurrent FSHV trials, ranging from 58.8 for Trial 7 to 65.4 for Trial 9 (6.6 points or 11.2%). These swings in performance level are reflected as a significant interaction effect without evident explanation. The pattern of performance changes is not consistently related to vehicle type.

Qualitative Results

The ride quality questionnaire (Appendix B) was administered near the end of test operations, after troops had gained considerable experience with both the FSHV and LVTP-7. Results are tabulated in Appendix C and discussed below.

Participant Background Information

The test group was comprised primarily of troops in Pay Grade E-3 (LCpl) with at least 2 years of service experience. All but two had previously participated in amphibious landings. Sixty-one percent indicated that motion sickness had not been a problem in previous landings; 28 percent, that it had caused them some minor discomfort; and 11 percent, moderate discomfort.

Ride Quality Assessment

Test subjects were asked to assess vehicle ride adequacy based on experience gained in underway trials (25 and 30 mph) conducted up to 25 July 1978. While this did not cover subsequent trials at 35 mph, the responses are considered applicable for the entire test period inasmuch as remaining trials had no observable adverse effect on troop performance.

Feeling About Ride. Two-thirds of the test subjects considered the FSHV ride satisfactory, and the remaining one-third considered it "fair."

Expected Combat Performance. Seventy-eight percent indicated that the predicted level of combat performance upon landing was satisfactory; and 22 percent that it was "fair."

Comparison with LVTP-7. Seventy-seven percent indicated that the FSHV ride was better than the LVTP-7 ride; 11 percent, that it was the same; and 22 percent, that it was worse.

Disliked Features. Despite a generally favorable assessment of the FSHV ride, certain features affecting ride comfort were disliked. These items should be considered for corrective action in the continuing LVA development program.

Ninety-four percent of the test subjects considered the temperature within the troop compartment to be excessive, although measurements indicated mean dry bulb temperature of only 85° F, with a maximum of 90° F. Mean wet bulb temperature of 78° F was recorded, indicating relative humidity of 80 percent. It is likely that high humidity contributed greatly to the feeling of heat discomfort. Emphasis should be placed on controlling the humidity level aboard the future LVA if practical.

Fifty-six percent of the participants indicated that vehicle slamming and jerking contributed to discomfort during landing trials. This problem might be alleviated by incorporating automotive shock absorbers as part of the support structure for benches in the troop compartment. Modifications of this type were implemented at Driver and Alternate Driver seats during the test and appeared to greatly reduce this problem.

Forty-four percent of the participants indicated concern about fumes in the troop compartment, although measured levels of carbon monoxide (6 ppm), nitrogen dioxide (0.6 ppm), and carbon dioxide (1,000 ppm) were far below hazard limits. The odor of diesel fumes can be unpleasant and may contribute to seasickness in some cases. It is difficult to arrange ventilation supply openings that totally avoid intake of exhaust fumes, but intake of exhaust fumes should be minimized by routing exhaust outlets away from ventilation openings in the future LVA.

Liked Features. Soundproofing was placed in bulkheads encompassing the troop compartment during vehicle construction. Seventy-two percent of the participants considered the low noise level within the troop compartment to be advantageous. This avoided the use of ear plugs and facilitated verbal communications between troops while underway. This technique was very successful, resulting in a noise level of only 76 dBA at speeds up to 30 mph, in contrast with the LVTP-7 troop compartment noise level of up to 104 dBA at 7 mph. Provisions for noise control should be included in design specifications for the future LVA.

Suggestions for Future Landing Vehicle

Two-thirds of the troops suggested that better ventilation and cooling should be provided for the future LVA. High capacity ventilation was incorporated in the FSHV troop compartment, measuring 444 cfm/man. The perception of poor ventilation may reflect a combination of high humidity, intake of diesel fumes, and occasional electrical power failure (blower deactivation). In any case, the future LVA should incorporate a reliable, high capacity ventilation system with dehumidifier provisions if feasible.

Fifty-six percent of the participants also suggested that more space should be provided in the troop compartment of the future LVA. The FSHV provided slightly less space per man than the LVTP-7, reducing the space between bench seats by 3 inches. In a crowded compartment (nine men seated in a deck area of 5.5 feet width by 5.6 feet length), a change of 3 inches can be noticeable to occupants. This space should be restored if possible in the future LVA.

CONCLUSIONS

1. There was less than 5 percent variation in the mean performance level of troops landing aboard the FSHV and LVTP-7 as shown by obstacle course run time, rifle firing ring score, and rifle firing group size when summarized in test phases corresponding to FSHV speed increments of 25, 30, and 35 mph. In most cases, the performance of troops landing aboard the FSHV was better than that of troops landing aboard the LVTP-7, although the difference was not statistically significant.

2. The FSHV ride was indicated as "satisfactory" by two-thirds of the test subjects. The remaining one-third considered the ride to be "fair." None of the subjects judged the ride as "poor."

3. Seventy-two percent of the participants considered the low noise level within the FSHV troop compartment to be advantageous. This avoided the use of ear plugs and facilitated verbal communications between troops while underway.

4. The most disliked feature of the FSHV troop compartment was the heat discomfort reported by 94 percent of the troops, although measured temperature did not exceed 90° F. It is likely that high relative humidity (typically 80%) while underway contributed to this perception of heat.

RECOMMENDATIONS

1. Design the future LVA to incorporate waterborne stability and ride quality characteristics equivalent to FSHV capabilities.

2. Incorporate the following habitability provisions aboard the future LVA:

a. Install noise and thermal insulation in bulkheads equivalent or superior to that in the FSHV.

b. If feasible, reduce heat discomfort by controlling the humidity level in troop spaces.

c. Divert exhaust fumes away from ventilation intake openings.

d. Provide a closed loop ventilation system as protection against chemical, biological, and radiological warfare hazards.

REFERENCE NOTES

1. Commandant of the Marine Corps ltr RDD-26-mrc of 2 February 1978, Subj: Required operational capability (ROC) No. MOB 1.05 for the Landing Vehicle Assault (LVA).

2. Amphibian Vehicle Test Branch, Camp Pendleton ltr D072/ADB:edh, 8410 Ser 64-78 of 25 May 1978, Subj: Specific test direction arrangements for continuation of full scale hydrodynamic vehicle (FSHV) tests.

3. FSHV master test plan. Bethesda, MD: David W. Taylor Naval Ship Research and Development Center (undated).

4. LVA full scale hydrodynamic vehicle (FSHV) ride quality demonstration plan. Camp Pendleton, CA: Amphibian Vehicle Test Branch, Marine Corps Tactical Systems Support Activity, May 1978.

5. BUMED ltr BUMED-0012/421/ehp, 3960 of 5 August 1977, Subj: Permission to use Marine infantrymen in an assessment of the ride quality of a proposed landing craft; request for.

6. Naval Regional Medical Center, San Diego ltr 78/JEL:dmf, 3900/548 of 26 July 1977, Subj: Full scale hydrodynamic vehicle (FSHV) test protocol; forwarding of

7. FSHV test protocol. Bethesda, MD: David W. Taylor Naval Ship Research and Development Center, 20 June 1977.

BIBLIOGRAPHY

Assault amphibian personnel carrier, experimental (LVTPX-12), engineering test: Final report (CMC Project No. 44-67-03 (U)). Quantico, VA: Marine Corps Development and Education Command, March 1969. CONFIDENTIAL

Band, E. F. W., & Rubies, C. J. Landing vehicle assault technology, Volumes I and II (Report No. 117-6). Annapolis, MD: Payne, Inc. Prepared for Office of Naval Research, October 1974.

BUMED Instruction 6260.2B, Subj: Hearing conservation program.

Effects of simulated ships motion on crew operations in a surface effect ship (Tech. Rep. 1057-1). Hawthorne, CA: Systems Technology, Inc. Prepared for Naval Sea Systems Command (PMS 304), Washington, DC, June 1975.

Gersten, A., & Dixon, W. B. Results of full scale trials on an LVTP-7 landing craft in waves and overland (TM-15-78-92). Bethesda, MD: David W. Taylor Naval Ship Research and Development Center, February 1978.

MIL-STD-1472B. Human engineering design criteria for military systems, equipment, and facilities. Washington, DC: Department of Defense, December 1974.

NAVMED P-5010-3. Manual of naval preventive medicine (Chapter 3, Ventilation and thermal stress ashore and afloat). Washington, DC: Department of the Navy, Bureau of Medicine and Surgery, 1974.

Stinson, W. J. Proposed test plan for evaluation of LVA full scale hydrodynamic vehicle motion effects on personnel performance. San Diego: Navy Personnel Research and Development Center, June 1977.

Threshold limit values for chemical substances and physical agents in the workroom environment. Cincinnati: American Conference of Governmental Industrial Hygienists, 1976.

APPENDIX A

PRINCIPAL TEST PARTICIPANTS

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LCpl John E. McDowell
LCpl Manuel B. Nanez, Jr.
LCpl David L. Owens
LCpl Keith H. Tierney
LCpl Mark A. Watson
Pfc George T. Giles

Kettenburg Marine Company, San Diego

Mr. Rene De Loach

[1]Volunteer test participants assigned to AVTB (TAD) during test period.

APPENDIX B

QUESTIONNAIRE

RIDE QUALITY EVALUATION OF LVA FULL-SCALE HYDRODYNAMIC VEHICLE

QUESTIONNAIRE

RIDE QUALITY EVALUATION OF LVA FULL-SCALE HYDRODYNAMIC VEHICLE

INTRODUCTION

Purpose

This study is directed toward evaluating the ride acceptability of the experimental Landing Vehicle Assault (LVA)/Full-Scale Hydrodynamic Vehicle (FSHV). The experimental planing hull vehicle is intended to deliver Marines to the beach at high speed without significant reduction in fighting capabilities upon landing. The FSHV ride will be compared with that of the existing LVTP-7.

Instructions

Answer each question as accurately and completely as possible. If additional space is needed for any item, continue on the reverse side of the sheet.

This study will provide information that can be used by various Navy and Marine Corps agencies in developing effective design features for the future LVA. The results will not affect individual test participants.

PARTICIPANT BACKGROUND INFORMATION

1. Name________________________________ 2. Rank/Pay Grade ____

3. Years in Service _____ 4. Job Specialty (MOS No.) __________________

5. Assigned seat location aboard vehicle (indicate by checkmark):

_______ a. Troop Compartment

_______ b. Pilot House

_______ c. Turret

______ d. Observer Compartment (Port)

______ e. Observer Compartment (Starboard)

6. Prior amphibious landings (indicate number below):

	No. of Landings
a. LVTP-7	________
b. Navy Landing Craft	________
c. Other (indicate type)____________	________

7. Indicate number of motion sickness problems (if any) during past landings:

	No. of Motion Sickness Occurences
a. LVTP-7	________
b. Navy Landing Craft	________
c. Other (indicate type)________	________

8. Level of motion sickness (if any) most often experienced in past landings (indicate by checkmark):

______ a. No previous problems

______ b. Minor discomfort

______ c. Moderate discomfort

______ d. Major discomfort

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RIDE QUALITY ASSESSMENT

1. Name ______________________ 2. Test Subject No. __________

3. Trial No. ______________________ 4. Vehicle Type __________

5. What is your feeling about the ride during this run?

   _____ a. Satisfactory

   _____ b. Fair

   _____ c. Poor

6. What kind of combat performance would you expect after this ride?

   _____ a. Satisfactory

   _____ b. Fair

   _____ c. Poor

7. How does this ride compare with that of the other test vehicle?

   _____ a. Better

   _____ b. Same

   _____ c. Worse

8. What did you dislike about the ride?

   _____ a. Ride O.K. (no problems)

   _____ b. Slamming and jerking

   _____ c. Rolling

   _____ d. Noise

   _____ e. Heat

   _____ f. Fumes

   _____ g. Other (describe) ______________________________

   ____

   ____

9. What did you like about the ride?

   _____ a. Nothing

   _____ b. Smooth

   _____ c. Quiet

   _____ d. Cool

   _____ e. Ventilation good

   _____ f. Other (describe) ______________________________

   ____

   ____

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SUGGESTIONS FOR FUTURE LANDING VEHICLE

1. Name ________________________________ 2. Test Subject No. __________

3. Date ____________________

4. Based on your experience in LVA/FSHV and LVTP-7 test operations, what features or improvements would you like to include in the future LVA (list below)?

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APPENDIX C

RIDE QUALITY QUESTIONNAIRE RESULTS

Table C-1

Participant Background Information

Question	Responses
Pay Grade	
E-2 (Pfc)	1
E-3 (LCpl)	15
E-4 (Cpl)	2
Years Service	
1 - 1.9	1
2 - 2.9	9
3 - 3.9	7
4 or more	1
Job Specialty	
0311	8
0331	1
0341	6
0351	3
Assigned Seat Location	
Troop Compartment	18
Prior Amphibious Landings	
LVTP-7	
None	2
1 - 2.9	5
3 - 5.9	3
6 - 8.9	1
9 or more	7
Navy Landing Craft	
None	4
1 - 2.9	5
3 - 5.9	2
6 - 8.9	2
9 or more	5
Prior Motion Sickness Problems	
None	11
Minor Discomfort	5
Moderate Discomfort	2
Major Discomfort	0

Table C-2

FSHV Ride Quality Assessment

Question	Responses
Feeling About Ride	
Satisfactory	12
Fair	6
Poor	0
Combat Performance Expected After Ride	
Satisfactory	14
Fair	4
Poor	0
Ride Comparison with LVTP-7	
Better	12
Same	2
Worse	4
Disliked Features	
No Problems	0
Slamming and jerking	10
Rolling	1
Noise	0
Heat	17
Fumes	8
Other:	
Not enough seat padding	2
Not enough space	2
Liked Features	
Nothing	3
Smooth	2
Quiet	13
Cool	1
Ventilation Good	0
Other:	
High Speed	2
Seat Padding	1

Table C-3

Suggestions for Future Landing Vehicle

Question	Responses
Desired Improvements for Future LVA	
None	3
Better ventilation/cooling	12
More space in troop compartment	10
Radio communications to keep troops informed	4
Observation ports	3
Smoother ride	3
Offensive gun	2
Watertight troop compartment	2
Quick access hatches	2
Heavy armor	1
Better seat padding	1

APPENDIX D

TABULATION OF OBSTACLE COURSE AND RIFLE FIRING SCORES

Table D-1

Obstacle Course Performance--Baseline and Posttest Trials

Trial No.		Date	Run Time[a]	Number of Errors
Baseline				
Before Running				
BBR1		6/15	34.0	0.4
BBR2		6/15	34.3	0.1
BBR3		6/15	33.4	0.0
	Overall		33.9	0.2
After Running[b]				
BAR1		7/11	32.9	0.1
BAR2		7/11	32.9	0.2
BAR3		7/11	33.1	0.1
	Overall		33.0	0.1
Before Running (Update)				
BBR1		7/14	31.9	0.4
BBR2		7/14	32.7	0.2
BBR3		7/14	32.8	0.2
	Overall		32.5	0.3
Posttest				
Before Running				
PBR1		8/14	30.6	0.1
PBR2		8/14	29.9	0.2
PBR3		8/14	28.4	0.4
	Overall		29.6	0.2
After Running				
PAR1		8/15	30.2	0.3
PAR2		8/15	31.6	0.1
PAR3		8/15	30.4	0.1
	Overall		30.7	0.1

[a]Run time quantified in seconds.

[b]Initial Baseline After Running phase was postponed to 7/11/78 in order to avoid delay in proceeding with vehicle landing trials. Updated Baseline Before Running phase was completed on 7/14/78 to provide concurrent evaluation data.

Table D-2

Obstacle Course Performance--LVTP-7 Landing Trials

Trial No.[a]	Date	Run Time[b]	Number of Errors
1	6/12	34.3	0.0
3	6/13	33.8	0.0
6	6/16	34.7	0.0
7	6/16	32.3	0.0
8	6/19	33.2	0.3
9	6/19	35.1	0.0
10	6/23	35.1	0.1
11	6/23	35.2	0.2
12	6/27	34.1	0.0
13	6/27	34.6	0.3
15	7/17	34.8	0.6
16	7/17	33.0	0.4
17	7/18	32.4	0.3
18	7/18	34.8	0.2
19	7/19	33.7	0.2
20	7/19	33.1	0.2
21	7/20	30.0	0.3
22	7/20	29.7	0.8
23	7/24	32.0	0.0
24	7/24	33.3	0.1
27	7/27	32.1	0.0
28	7/27	34.2	0.1
30	7/31	31.0	0.0
31	8/2	31.4	0.1
32	8/2	32.4	0.0
	Overall	33.2	0.2

[a]Trial runs 2, 4, 5, 14, 25, 26, and 29 are omitted due to operational problems that precluded satisfactory compliance with specified test procedures.

[b]Run time quantified in seconds.

Table D-3

Obstacle Course Performance--FSHV Landing Trials

Trial No.[a]	Date	Run Time[b]	Number of Errors
1	6/12	33.3	0.0
3	6/13	32.3	0.4
6	6/16	32.0	0.6
7	6/16	33.9	0.0
8	6/19	32.2	0.1
9	6/19	30.7	0.1
10	6/23	34.9	0.4
11	6/23	34.7	0.0
12	6/27	34.3	0.2
13	6/27	33.9	0.2
15	7/17	31.2	0.1
16	7/17	32.8	0.0
17	7/18	33.2	0.2
18	7/18	31.8	0.0
19	7/19	31.6	0.3
20	7/19	34.3	0.0
21	7/20	33.3	0.3
22	7/20	31.1	0.2
23	7/24	33.3	0.1
24	7/24	30.7	0.0
27	7/27	32.7	0.4
28	7/27	31.6	0.4
30	7/31	32.0	0.0
31	8/2	33.9	0.1
32	8/2	30.9	0.0
	Overall	32.7	0.2

[a]Trial runs 2, 4, 5, 14, 25, 26, and 29 are omitted due to operational problems that precluded satisfactory compliance with specified test procedures.

[b]Run time quantified in seconds.

Table D-4

Rifle Firing Performance--Baseline and Posttest Trials

Trial No.	Date	Ring Score	Centroid Miss Distance[a]	Group Size[a]	Unfired Rounds
Baseline					
Before Running					
BBR1	6/29	67.1	5.7	522.6	0.1
BBR2	6/29	66.8	6.7	545.8	0.0
BBR3	6/29	70.7	5.0	492.1	0.0
Overall		68.2	5.8	520.2	-
After Running[b]					
BAR1	7/11	65.3	6.4	614.9	0.0
BAR2	7/11	67.4	5.3	572.5	0.0
BAR3	7/11	69.3	5.0	514.9	0.0
Overall		67.3	5.6	567.4	0.0
Before Running (Update)					
BBR1	7/13	68.2	5.8	460.7	0.1
BBR2	7/13	71.7	4.4	465.9	0.0
BBR3	7/13	70.8	4.9	482.2	0.0
Overall		70.2	5.0	469.6	-
Posttest					
Before Running					
PBR1	8/14	72.3	4.6	436.3	0.0
PBR2	8/14	72.7	5.1	443.0	0.1
PBR3	8/14	71.3	4.9	479.6	0.1
Overall		72.1	4.9	453.0	0.1
After Running					
PAR1	8/15	71.4	4.4	493.0	0.0
PAR2	8/15	70.7	5.0	467.3	0.0
PAR3	8/15	72.8	4.9	409.9	0.0
Overall		71.6	4.8	456.7	0.0

[a]Centroid miss distance quantified in millimeters. Group size quantified in millimeters^2.

[b]Initial Baseline After Running phase was postponed to 7/11/78 in order to avoid delay in proceeding with vehicle landing trials. Updated Baseline Before Running phase was completed on 7/13/78 to provide concurrent evaluation data.

Table D-5

Rifle Firing Performance--LVTP-7 Landing Trials

Trial No.[a]	Date	Ring Score	Centroid Miss Distance[b]	Group Size[b]	Unfired Rounds
1	6/12	57.1	7.7	900.8	0.3
3	6/13	59.4	8.4	725.7	0.3
6	6/16	64.6	6.0	649.5	0.1
7	6/16	68.4	5.2	561.7	0.0
8	6/19	63.6	7.4	721.6	0.2
9	6/19	57.8	6.8	859.3	0.0
10	6/23	61.4	7.8	677.5	0.0
11	6/23	65.2	6.7	624.2	0.0
12	6/27	68.4	4.9	548.9	0.1
13	6/27	68.9	3.8	513.3	0.1
15	7/17	65.1	7.9	521.5	0.1
16	7/17	68.9	7.1	494.0	0.1
17	7/18	71.3	6.7	466.5	0.0
18	7/18	62.9	8.2	541.0	0.1
19	7/19	67.2	6.2	548.4	0.0
20	7/19	66.2	4.8	612.2	0.1
21	7/20	60.8	6.1	629.8	0.0
22	7/20	71.9	4.1	477.3	0.0
23	7/24	70.2	4.6	505.8	0.1
24	7/24	71.0	5.7	453.1	0.0
27	7/27	69.0	5.2	496.2	0.0
28	7/27	67.2	4.6	527.2	0.1
30	7/31	69.7	5.7	490.4	0.0
31	8/2	69.6	5.4	499.5	0.0
32	8/2	66.9	7.0	480.6	0.0
	Overall	66.2	6.2	581.0	-

[a]Trial runs 2, 4, 5, 14, 25, 26, and 29 are omitted due to operational problems that precluded satisfactory compliance with specified test procedures.

[b]Centroid miss distance quantified in millimeters. Group size quantified in millimeters^2.

Table D-6

Rifle Firing Performance--FSHV Landing Trials

Trial No.[a]	Date	Ring Score	Centroid Miss Distance[b]	Group Size[b]	Unfired Rounds
1	6/12	58.6	8.7	711.5	0.1
3	6/13	60.7	6.8	766.8	0.9
6	6/16	61.0	6.3	706.2	0.1
7	6/16	58.8	8.7	704.8	0.2
8	6/19	58.9	8.9	703.5	0.1
9	6/19	65.4	6.7	604.6	0.1
10	6/23	63.9	7.2	651.3	0.2
11	6/23	62.2	7.4	639.5	0.0
12	6/27	59.2	6.9	703.1	0.0
13	6/27	64.2	7.0	790.4	0.2
15	7/17	69.0	5.5	511.9	0.0
16	7/17	67.6	6.7	544.8	0.0
17	7/18	65.0	7.9	512.4	0.0
18	7/18	70.8	4.5	516.8	0.0
19	7/19	69.1	4.3	611.6	0.0
20	7/19	67.1	5.1	580.4	0.0
21	7/20	70.0	4.0	530.7	0.0
22	7/20	66.3	7.4	516.8	0.0
23	7/24	63.0	7.3	684.7	0.0
24	7/24	69.0	5.2	496.2	0.0
27	7/27	69.2	6.4	455.8	0.0
28	7/27	73.8	4.5	428.6	0.0
30	7/31	71.0	3.7	451.6	0.0
31	8/2	68.0	6.2	478.4	0.0
32	8/2	71.7	4.1	521.6	0.0
	Overall	65.7	6.3	589.0	-

[a]Trial runs 2, 4, 5, 14, 25, 26, and 29 are omitted due to operational problems that precluded satisfactory compliance with specified test procedures.

[b]Centroid miss distance quantified in millimeters. Group size quantified in millimeters^2.

APPENDIX E

ANALYSIS OF VARIANCE RATIOS

Table E-1

Analysis of Variance--Vehicle Landings
(FSHV vs. LVTP-7)

Dependent Variable (Performance Measure)	Trial Runs	F Ratios		
		Vehicle Effect	Trial Mode Effect	Interaction Effect
Obstacle Course Run Time	1,3	0.88	0.36	0.03
	6,7,8,9	3.39	0.09	2.05
	10,11,12,13	0.08	0.22	0.04
	15,16,17,18,19,20	0.92	0.25	0.63
	21,22,23,24,27,28,30	0.00	1.08	0.74
	31,32	0.12	0.63	2.54
Ring Score	1,3	0.17	0.29	0.00
	6,7,8,9	1.59	0.29	3.25*
	10,11,12,13	0.38	0.64	2.23
	15,16,17,18,19,20	0.23	0.37	1.76
	21,22,23,24,27,28,30	1.08	2.71	2.61
	31,32	0.37	0.04	1.43
Centroid Miss Distance	1,3	0.05	0.16	0.69
	6,7,8,9	2.87	1.33	1.16
	10,11,12,13	2.40	1.34	0.88
	15,16,17,18,19,20	5.42*	1.90	2.17
	21,22,23,24,27,28,30	0.54	0.72	1.87
	31,32	0.90	0.06	3.18
Group Size	1,3	0.56	0.21	1.08
	6,7,8,9	0.07	0.37	1.44
	10,11,12,13	0.62	0.06	2.44
	15,16,17,18,19,20	0.27	1.04	0.53
	21,22,23,24,27,28,30	1.06	1.93	1.87
	31,32	0.02	0.03	0.21

*Indicates significant effect at 0.05 level.

Table E-2

Analysis of Variance--Beginning Baseline
(Updated BBR vs. BAR)

Dependent Variable (Performance Measure)	Trial Runs	F Ratios		
		Running Effect	Trial Mode Effect	Interaction Effect
Obstacle Course Run Time	1, 2, 3	1.58	0.07	0.17
Ring Score	1, 2, 3	0.30	2.28	0.25
Centroid Miss Distance	1, 2, 3	0.22	1.68	1.42
Group Size	1, 2, 3	1.44	1.00	0.26

Table E-3

Analysis of Variance--Termination Baseline
(PBR vs. PAR)

Dependent Variable (Performance Measure)	Trial Runs	F Ratios		
		Running Effect	Trial Mode Effect	Interaction Effect
Obstacle Course Run Time	1, 2, 3	1.18	0.10	0.71
Ring Score	1, 2, 3	5.38*	0.44	1.45
Centroid Miss Distance	1, 2, 3	1.44	0.47	1.92
Group Size	1, 2, 3	4.55*	1.01	0.07

*Indicates significant effect at 0.05 level.

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